ACTA POLYTECHNICA SCANDINAVICA

ANNOTATED INDEX 1984

HELSINKI 1984

ACTA POLYTECHNICA SCANDINAVICA

Annotated Index 1984

C O N T E N T S

ACTA POLYTECHNICA SCANDINAVICA 1984

Ch Chemical Technology and Metallurgy Series (formerly Chemistry including Metallurgy Series)

Ch 154 Turunen, I., Järveläinen, M. and Dohnal, M., *A Fuzzy Method for Multicriteria Decision Making*
Ch 155 Turunen, I., *Modern Methods for Cost Estimation and Decision-Making in Preliminary Plant Design*
Ch 156 Toivonen, H.J., *Studies on Autoxidizable N,N'-Bis(methoxymethyl)-urea Copolycondensates and Autoxidation of Allyl Ether Compounds*
Ch 157 Piik, H.T. and Laine, J.I., *Prediction of Heat Transfer Coefficient from Pressure Drop in Pipes*
Ch 158 Heiskanen, T.H. and Nordén, H.V., *Dynamics and Stability of an MSMPR-Crystallizer with Fines Dissolving*
Ch 159 Odeyemi, S.O., *Reactions of Raphia Hookeri under Some Major Chemical Pulping Processes*

Ci Civil Engineering and Building Construction Series

Ci 82 Kukkonen, H., *A Design Language for a Self-Planning System. A procedural development study based on practical experiments with small-group housing*

El Electrical Engineering Series

El 52 Pajunen, G.A., *Application of a Model Reference Adaptive Technique to the Identification and Control of Wiener Type Nonlinear Processes*
El 53 Luomi, J., *Magnetic Field Analysis of Superconducting Homopolar Machines*
El 54 Henriksson, J., *Decision Directed Diversity Combiners for Digital Radio Links*

Ma Mathematics and Computer Science Series

Ma 41 Rajala, J., Sarvas, J. and Soikkeli, J., *Electromagnetic Scattering from an Inhomogeneity in a Half Space by the Method of Successive Reflections*
Ma 42 Manninen, M., *Task-Oriented Approach to Interactive Control of Heavy-Duty Manipulators Based on Coarse Scene Description*

Me Mechanical Engineering Series

Me 85 Räty, R., Isomäki, H.M. and von Boehm, J., *Chaotic Motion of a Classical Anharmonic Oscillator*
Me 86 Koski, J., *Bicriterion Optimum Design Method for Elastic Trusses*
Me 87 Räty, R., von Boehm, J. and Isomäki, H.M., *Asymmetric Chaotic Swinging and Its Universality*
Me 88 Härkönen, E.J., *Mathematical Model for Two-Phase Flow*

Ph Applied Physics Series

Ph 141 Rytsölä, K., *Positron Induced Cluster and Positronium Bubble in Low Temperature Fluids*
Ph 142 Järvinen, M.-L., *The Use of Penning Mixtures in Proportional Counters*
Ph 143 Puska, M., *Theoretical Studies of Impurity-Metal Interactions*
Ph 144 Orbeck, F., *A Method Based on Probability of Adding the Individual Modes of Thermal Vibration and Predicting Their Effect on the Strength of Aluminium Crystals*
Ph 145 Rajala, J. and Soikkeli, J., *On the Determination of the Magnetic Dipole and Quadrupole Moments*
Ph 146 Sandberg, J.V., *Determination of Particle Flux Spectra with Multireaction Activation Detectors*
Ph 147 Lund, P.D., *Studies on Solar Heating Systems with Long-Term Heat Storage for Northern High Latitudes*

ABSTRACTS

CHEMICAL TECHNOLOGY AND METALLURGY SERIES
(former Chemistry including Metallurgy Series)

Ch 154 UDC 66.012.77:519.816:519.876

Turunen, I., Järveläinen, M. and Dohnal, M.: *A Fuzzy Method for Multicriteria Decision Making*. Acta Polytechnica Scandinavica, Chemical Technology and Metallurgy Series No. 154, Helsinki 1984, 28 pp. ISBN 951-666-173-4. ISSN 0001-6853.

The fuzzy method presented in this paper has been developed for practical problems of choosing between alternatives. A fuzzy model is formulated to describe the effects of the criteria of choice. These criteria are the independent variables of the model and the acceptability of the alternatives is the dependent one. The fuzzy values of the criteria are given as input data to the model separately for each alternative. As a result a membership function of the acceptability of each alternative is obtained.

The method is quite flexible because the model can be formulated according to the requirements of the problem in question. The approach is especially suitable for complex problems, for instance if the degrees of importance of some criteria depend on their values or on the values of other criteria.

The method is described through an example of process selection, although it can be applied to any problem of choosing between alternatives.

Ch 155 UDC 66.013.5:658.152:519.226
519.816

Turunen, I.: *Modern Methods for Cost Estimation and Decision-Making in Preliminary Plant Design*. Acta Polytechnica Scandinavica, Chemical Technology and Metallurgy Series No. 155, Helsinki 1984, 34 pp. ISBN 951-666-184-X. ISSN 0001-6853.

This thesis is based on six different publications in which new methods for the capital cost estimation of chemical plants and for decision-making are presented. The methods are applicable mainly at the early stages of a plant design project.

Fuzzy modelling is applied to capital cost estimation. This thesis shows how subjective, ill-defined knowledge, normally used together with estimating procedures, can be transformed into a mathematical form and included in the estimating methods themselves. Estimation of both the total plant investment and equipment costs is treated.

A fuzzy method for decision-making is presented and demonstrated with an example of process selection. The method is applicable to complicated situations of decision-making when the relative degrees of importance of some criteria may depend on their values and on the values of other criteria.

Combining cost estimating methods with a flowsheeting program is also demonstrated.

Ch 156 UDC 667.621.2:541.128.24

Toivonen, H. J.: *Studies on Autoxidizable N,N'-Bis(methoxymethyl)urea Copolycondensates and Autoxidation of Allyl Ether Compounds*. Acta Polytechnica Scandinavica, Chemical Technology and Metallurgy Series No.156, Helsinki 1984, 36 pp. ISBN 951-666-186-6. ISSN 0001-6853.

This paper summarizes the results of studies on amino resins containing allyl ether groups prepared by polycondensating N,N'-bis(methoxymethyl)-urea with trimethylolpropane diallyl ether and 2-ethylhexanol. The effects of monomeric composition, autoxidation catalyst, molar mass and molar mass distribution of the resins on their autoxidative film formation performance were explored and the stability of the resins in aqueous solutions was investigated by monitoring changes in the solutions on ageing and by studying the hydrolysis of N,N'-bis(methoxymethyl)urea as a model reaction. The properties of solvent-based water-thinnable paints and emulsion paint formulations prepared by using the resins as binders were studied. Liquid-phase cobalt-catalyzed autoxidations of allyl ethers of some diols and monohydric alcohols were studied. A mechanism is suggested for the induction period in the autoxidation of allyl ether alcohols. The effect of the structure of the alkyl groups on the autoxidation rate of alkyl allyl ethers is discussed.

Ch 157 UDC 66.045

Piik, H. T. and Laine, J. I.: *Prediction of Heat Transfer Coefficient from Pressure Drop in Pipes*. Acta Polytechnica Scandinavica, Chemical Technology and Metallurgy Series No. 157, Helsinki 1984, 21 pp. ISBN 951-666-188-2. ISSN 0781-2698 (formerly 0001-6853).

An equation is derived which enables the heat transfer coefficient between the liquid and the pipe wall to be calculated as a function of pressure drop in the pipe. The equation is based on the Nusselt analogy and the use of the Kolmogoroff scale of microturbulence.

The heat transfer coefficient in the equation depends on the roughness of the pipe surface. The expression derived has the advantage that roughness is eliminated and replaced by the more easily measurable pressure drop.

Ch 158 517.957:517.983:66.021

Heiskanen, T. H. and Nordén, H. V.: *Dynamics and Stability of an MSMPR-Crystallizer with Fines Dissolving*. Acta Polytechnica Scandinavica, Chemical Technology and Metallurgy Series No. 158, Helsinki 1984, 45 pp. ISBN 951-666-189-0. ISSN 0781-2698.

We demonstrate that a double Laplace transform can be applied in investigating the stability of an MSMPR-crystallizer with fines dissolving, even though the original equations for the process dynamics of the crystallizer and the linearized equations with respect to time are nonlinear with respect to the length of crystals. The equations for the Laplace transforms of the first four moments of crystal size distribution are derived and a numerical example is given for the response of these moments as a function of time after a step change in residence time. A general stability criterion is derived and the roots of the characteristic equation are calculated numerically for different values of two parameters of the system. It was concluded that the damping factor of the crystal size variations cannot be improved by changing the recirculation rate or classification size of fines without decreasing the dominant size of the product crystals.

Ch 159 UDC 676.022.62

Odeyemi, S. O.: *Reactions of Raphia Hookeri under Some Major Chemical Pulping Processes*. Acta Polytechnica Scandinavica, Chemical Technology and Metallurgy Series No. 159, Helsinki 1984, 60 pp. ISBN 951-666-191-2. ISSN 0781-6853.

Raphia palm (Raphia hookeri) chips were digested using the acid bisulfite, soda, kraft and neutral sulfite processes. In spite of the high chemical charge, the high cooking temperature and the long cooking time, under the acid bisulfite process, raphia could not be pulped to a satisfactory degree of delignification. The yield and the brightness associated with the pulps are poor. The strength properties are slightly lower especially in tensile and burst indexes than those of hardwood acid bisulfite pulps. The production of soda pulps requires a high chemical charge (18% effective alkali) and an application of a high H-factor (2006). Kraft pulping requires a lower chemical charge (about 16% effective alkali) and a lower H-factor (604). An addition of AQ as a catalyst increases the rate of delignification of the soda process more than it does in respect of the kraft process. AQ increases the yield in soda more than it does in kraft. Bleachable grades of pulps are obtained from the neutral sulfite process without the use of a catalyst (AQ). The application of a total alkali charge of 23%, a cooking temperature of 175 ^{o}C and a cooking time of 3 hours appear to constitute the optimum conditions for the neutral sulfite process. The papermaking properties of the pulp are notably lower than those of the kraft pulps. The high tear index (14 mMm^2/g in kraft pulp) observed for raphia may be corre-

lated with the long fiber length (2.41 mm). Raphia fibers easily collapse and this may explain the noticed easy beatability. The high content of parenchyma cells may account for the low values of burst and tensile indexes. Raphia is obviously better than Gmelina arborea and many common hardwoods in tear index. Important factors which would influence pulpmills in the future and the possible features of mill based on raphia as pulpwood are briefly discussed.

CIVIL ENGINEERING AND BUILDING CONSTRUCTION SERIES

Ci 88

UDC 711.1
72.011

Kukkonen, H.: *A Design Language for a Self-Planning System.* Acta Polytechnica Scandinavica, Civil Engineering and Building Construction Series No. 82, Helsinki 1984, 141 pp. ISBN 951-666-198-X. ISSN 0355-2705.

This published study presents a method of participatory planning which is called self-planning and is intended for use by laymen. It is adapted to the planning of habitation and the living environment especially in the case of building groups of one-family houses. Self-planning promotes the formation of tightly knit community of residents. It is based on a pre-prepared step-by-step planning process in which the lay planners work under the guidance of an expert. Self-planning progresses with the aid of a log book and is supported by related auxiliary information and equipment. The equipment of self-planning consists of 2- and 3-dimensional pictures and 1:15 and 1:100 scale models depicting the object of planning. This system enables a level of depth corresponding to the resident's prerequisites and motivation for the planning. A cost monitoring system that keeps pace with the planning is an integral part of the self-planning system. This facility enables the lay planner to make sure that his plan is kept within fixed cost limits. The study is to a large extent based on the results of practical tests and the conclusions drawn from them.

ELECTRICAL ENGINEERING SERIES

El 52 UDC 681.513.66

Pajunen, G. A.: *Application of a Model Reference Adaptive Technique to the Identification and Control of Wiener Type Nonlinear Processes.* Acta Polytechnica Scandinavica, Electrical Engineering Series No. 152, Helsinki 1984, 130 pp. ISBN 951-666-182-3. ISSN 0001-6845.

This study is concerned with a problem of the on-line identification and adaptive control of a Wiener type nonlinear process. It is assumed that the linear dynamic part of the process can be approximated by a stable pulse transfer function model of a known order followed by a pure time-delay. The static nonlinearity is assumed to be a monotonical function of its argument and it is approximated by a piecewise-polynomial function model. The output signal from the linear part is not available for measurement. The combined model is nonlinear in its parameters and it is characterized by a larger number of parameters than the original Wiener model.

Deterministic globally stable recursive parameter identification algorithms and the model reference adaptive control systems are developed for the Wiener process model. The asymptotic properties in the presence of the input and output measurement noises and the influence of the error due to the approximation of a static nonlinearity by a piecewise-polynomial function of a finite order on the convergence properties of the proposed identification schemes are analysed. Finally, the on-line identification and adaptive control of the pH-process in a continuous flow reactor were performed. The simulation and the experimental test results are presented.

El 53 UDC 537.612:519.61/.64:621.313.291:538.945

Luomi, J.: *Magnetic Field Analysis of Superconducting Homopolar Machines* Acta Polytechnica Scandinavica, Electrical Engineering Series No. 53, Helsinki 1984, 109 pp. ISBN 951-666-179-3. ISSN 0001-6845.

The report deals with the solution of axisymmetric magnetostatic fields with special reference to superconducting homopolar machines. Axisymmetric fields are conveniently represented by single-component vector potentials. Solution by the isoparametric finite element method is described. The method is based on approximate stationary of an energy functional, and it allows easy handling of material inhomogeneities and nonlinearities. A formulation of the boundary element method is developed for problems with linear and homogeneous material. Isoparametric representation of boundaries and boundary values is used, and the solution is achieved by an application of the Galerkin method on the integral equation of the field. An approach for combining finite element and boundary element methods is presented. The methods are given both for total and reduced vector potentials. Numerical examples illustrate the benefits of the combined method and reduced vector potential in superconducting homopolar machine applications.

E1 54 UDC 621.396.94:621.396.666

Henriksson, J.: *Decision Directed Diversity Combiners for Digital Radio Links*. Acta Polytechnica Scandinavica, Electrical Engineering Series No. 54, Helsinki 1984, 202 pp. ISBN 951-666-195-5. ISSN 0001-6845.

Medium and high capacity digital microwave radio links employing QAM signalling are studied theoretically and by computer simulations in selectively fading channels. Countermeasures to multipath fading such as method of carrier regeneration, equalizers, and diversity combiners are discussed. The optimality of the decision directed loop (DDL) for carrier regeneration in a two-path channel in the minimum mean square error (MMSE) sense is pointed out. A new class of decision directed diversity combiners for digital radio links is introduced. Two subgroups of these combiners, minimum mean square error and minimum projection (MP) combiners, are defined and analyzed. The MP principle, in particular, leads to promising combiners capable of obeying either the maximal ratio or the minimum dispersion rule, depending on the degree of dispersion in the channel. In addition to the theoretical optimum schemes, several suboptimum, practical receiver block schemes are outlined. The problem of performance measures for diversity receivers is discussed and a new method for defining diversity signatures is proposed. Finally, several series of diversity signatures evaluated by computer simulations for these new combiners are given for a 4 PSK 70 Mbit/s system.

MATHEMATICS AND COMPUTER SCIENCE SERIES

Ma 41 UDC 537.874.4:519.63

Rajala, J., Sarvas, J. and Soikkeli, J.: *Electromagnetic Scattering from an Inhomogeneity in a Half Space by the Method of Successive Reflections* Acta Polytechnica Scandinavica, Mathematics and Computer Science Series No. 41, Helsinki 1984, 35 pp. ISBN 951-666-190-4. ISSN 0355-2713.

A method is constructed for computing electromagnetic scattering from an inhomogeneity buried in a homogeneous lossy ground numerically. The EM-source lying on the ground level has a harmonic time dependence. A formula for the scattered field is derived in terms of successive reflections between the scatterer and the ground surface. For the numerical implementation of the method the T-matrix of a half space is computed in the spherical wave basis. The scattering from the scatterer when it lies in a full space is assumed to be known, for instance, via its T-matrix. The use of spherical waves enables us to carry out the computations mainly with fast Hankel transforms which makes the method numerically effective. As a numerical example the case of a homogeneous sphere in a lossy ground with a vertical magnetic dipole in the audio frequency range as the EM-source is treated.

Ma 42 UDC 007.52:519.683:681.3.015:510.5

Manninen, M.: *Task-Oriented Approach to Interactive Control of Heavy-Duty Manipulators Based on Coarse Scene Description.* Acta Polytechnica Scandinavica, Mathematics and Computer Science Series No. 42, Helsinki 1984, 81 pp. ISBN 951-666-193-9. ISSN 0355-2713.

A new supervisory method based on the use of a coarse model of the task environment is proposed for programming and monitoring the performance of heavy-duty manipulators (HDM) designed to operate in hazardous and unstructured environments. The model is interactively created by a pointer associated with a menuboard. Machine trajectories are automatically planned on the basis of the model according to the instructions directed to control the manipulation. Task monitoring is carried out by debugging the model according to the changes in the environment. The human operator may also lead the end of the arm of the machine by the pointer during run-time.

The proposed method was adapted to a case example of an experimental log-loader to demonstrate the feasibility of the approach. The human-computer interface to support the use of the method was designed and implemented. The interface contains aids for the model creation, a pointer and a menuboard, and a graphics display to present the state of the model by pictorial means. The necessary software for automatic planning of machine trajectories was developed and implemented for

simulation studies. The experimental implementation and the tests carried out reveal that a suitable human-computer interface to meet the actual requirements can be designed and that collision-free trajectories for the machine and for its payload can be computed also in practical applications.

The major importance of the method is that it relieves the human operator from steering the machine for supervising the manipulation. Although the method is designed basicly for interactive machines, it is applicable also to programming industrial robots.

MECHANICAL ENGINEERING SERIES

Me 85 UDC 531.32

Räty, R., Isomäki, H.M. and von Boehm, J.: *Chaotic Motion of a Classical Anharmonic Oscillator.* Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 85, Helsinki 1984, 30 pp. ISBN 951-666-175-0. ISSN 0001-687X.

The chaotic motion of the classical Duffing's oscillator (equation of motion: $\ddot{x} + 0.4\dot{x} + x - 4x^3 = 0.115 \cos(rt)$) is studied. It is found for decreasing r that the larger inversion-symmetric limit cycle splits into two asymmetric limit cycles being inversions of each other at $r \cong 0.535$. The asymmetry increases until each limit cycle starts period-doubling bifurcations at r = 0.53. The chaotic region starts at $r \cong 0.528$. It is interrupted by periodic windows appearing in the sequence 6, (12), 5, 3, (6, 12), 8, 7, 5 (the bifurcated periods within windows in parentheses). This sequence is consistent with the universal sequence of Metropolis et al. for one-dimensional maps. The two asymmetric strange attractors (being related via inversion-symmetry to each other) merge at r = 0.5268 to form the inversion-symmetric strange attractor making all subsequent attractors (including periods 7 and 5) inversion-symmetric.

Me 86 UDC 624.041:519.85

Koski, J.: *Bicriterion Optimum Design Method for Elastic Trusses.* Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 86, Helsinki 1984, 68 pp. ISBN 951-666-185-8. ISSN 0001-687X.

An interactive optimum design method for elastic trusses is proposed. The method is based on the bicriterion problem formulation where the vector objective function consists of the volume of a structure and a linear combination of some chosen nodal displacements. Both physical and mathematical arguments are used to prove the applicability of the bicriterion approach. Compared with the corresponding multicriterion problem, where each chosen displacement is treated as a separate criterion in addition to the volume, the proposed approach has some advantages. Especially, only one trade-off is needed in the decision-making process and a graphic illustration of the design process in the criterion space is possible. The minimax technique is applied to generating Pareto optimal solutions to the bicriterion problem. The method includes two types of parameters which can be varied during the design process. A procedure for determining new values for them at every current Pareto optimum is presented. Also the computation of the initial design is considered. The application as well as the convergence of the method is discussed and two examples are given to illustrate the design process.

Me 87 UDC 531.32

Räty, R., von Boehm, J. and Isomäki, H.M.: *Asymmetric Chaotic Swinging and Its Universality*. Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 87, Helsinki 1984, 26 pp. ISBN 951-666-197-1. ISSN 0001-687X.

The chaotic swinging of the pendulum-type equation of motion $\ddot{\varphi} + 0.4\dot{\varphi} + \varphi - \varphi^3/6 = 0.04085 + 0.5634 \cos(\omega t)$ is studied numerically having the angular frequency ω as the system parameter. The chaotic motion occurs in the large amplitude swinging branch. With decreasing ω the chaotic swinging is found to be preceded by Feigenbaum's period-doubling bifurcation sequence. The chaotic region starting at $\omega \cong 0.5713$ is found to be interrupted by (at least) the periodic windows 24, 12, 14, 10, 6→12, 28, 16, 7, 5→10, 7, 12, 9, 5 and 4 (given in units $2\pi/\omega$, the arrows indicate period-doublings within the windows). The periodic window 3 does not occur. The sequence of the periods (≤ 11) agrees with the universal sequence of Metropolis et al. excluding the last two periods, 5 and 4. The right-left structures of the periodic attractors agree with the universal structures of Metropolis et al. except for the last three periods, 9, 5, and 4. The jump to the small amplitude swinging branch occurs at $\omega \cong 0.566$. With increasing the jump from the small amplitude swinging branch to the large amplitude swinging branch occurs at $\omega \cong 0.68$.

Me 88 UDC 66.023:532.58
676.1.052

Härkönen, E.J.: *A Mathematical Model for Two-Phase Flow*. Acta Polytechnica Scandinavica, Mechanical Engineering Series No. 88, Helsinki 1984, 65 pp. ISBN 951-666-194-7. ISSN 0001-687X.

The chemical processing industry operates two-phase chemical reactors in a multitude of applications. The solid particles often form porous and compressible columns. Liquid reactants in co-current, counter-current or cross-current flow relative to solid modify properties of the solid material through the process. This work presents a new flow model that describes internal pressure and temperature distributions as well as velocities for both phases. The model considers the solid phase porous and flexible.

APPLIED PHYSICS SERIES

Ph 141 UDC 539.124.6:538.953:536.48

Rytsölä, K.: *Positron Induced Cluster and Positronium Bubble in Low Temperature Fluids*. Acta Polytechnica Scandinavica, Applied Physics Series No. 141, Helsinki 1984, 33 pp. ISBN 951-666-178-5. ISSN 0355-2721

The results of positron lifetime measurements presented in this thesis show that in helium fluids at low enough temperatures the atoms form a droplet-like cluster around the positron in total analogy with ordinary condensation, and the same phenomenon also occurs in nitrogen with only minor differences. Theoretical calculations confirm the results. Bubble formation around the positronium is observed in helium in all phases but its onset is not as abrupt as that of clustering. Analysis of the results yields the sizes of the inhomogeneities and also estimates for the appropriate scattering lengths.

Ph 142 UDC 539.1:621.387

Järvinen, M.-L.: *The Use of Penning Mixtures in Proportional Counters*. Acta Polytechnica Scandinavica, Applied Physics Series No. 142, Helsinki 1984, 36 pp. ISBN 951-666-176-9. ISSN 0355-2721.

The kinetics of the lowest four excited states of rare gases with parent gas atoms and various molecules are reviewed. The effect of these processes on the energy resolution of proportional counters filled with Penning mixtures is discussed. The gas amplification in a neon/argon filled proportional counter propagates mainly via the Penning process. However, the increase in the variance in gas amplification as a function of gain in this gas mixture is determined by a small fraction of ionization mediated by photons.

Ph 143 UDC 538.915:539.219.1:533.583.2

Puska, M.: *Theoretical Studies of Impurity-Metal Interactions*. Acta Polytechnica Scandinavica, Applied Physics Series No. 143, Helsinki 1984 48 pp. ISBN 951-666-180-7. ISSN 0355-2721.

This thesis deals with the properties of impurities, in particular hydrogen, in metals. The subject is enlarged to include the chemisorption of hydrogen, positron states, and core-level excitations in metals. The thesis is based on eight publications. The electron structures of atomic impurities are calculated using the Kohn-Sham method based on the density functional formalism. The metal host is described via the uniform jellium model. The model is used to calculate the immersion energies into an electron gas for free atoms, the scattering of Fermi-surface electrons due to the impurities, and the free-atom-metal shifts in

kinetic energies for electrons ejected in X-ray photoemission or Auger processes. The model is shown to describe well the nonlinear screening effects in metallic environment. In this thesis also a practical calculational scheme for hydrogen and helium impurities is presented. The scheme is based on the quasiatom theory in calculating the impurity potential in a discrete metal lattice. The lattice deformation and the zero-point motion of the impurity are included. It is shown that these phenomena are important for the understanding of trapping, diffusion, and excitation processes. The scheme is also used to describe the chemisorbed state of hydrogen on metal surfaces. An analogous scheme is developed for positron states in metals and annihilation characteristics for positrons trapped at various types of defect complexes in metals are predicted.

Ph 144 UDC 536.1:539.4.01

Orbeck, F.: *A Method Based on Probability of Adding the Individual Modes of Thermal Vibration and Predicting Their Effect on the Strength of Aluminium Crystals*. Acta Polytechnica Scandinavica, Applied Physics Series No. 144, Helsinki 1984, 42 pp. ISBN 951-666-174-2. ISSN 0355-2721.

The transverse thermal vibrations propagating in the directions perpendicular to the slip planes, are treated as one dimensional and a formula relating plastic strain rate to applied stress, internal stress and temperature is derived. It is assumed that each mode of vibration contribute a stress of the same magnitude and that this stress can be either positive or negative. The binomial theory is used to predict the probability of any combination of positive and negative stresses and therefore the resultant stress. It is then replaced by the normal probability distribution.

The thermal vibration stresses vary with high frequencies. When the stress between two slip planes exceeds the strength, local slip will take place. The applied stress will increase the incidence of slip in its own direction and reduce it in the opposite direction. A formula, similar in form to formulae based on the partition function in statistical mechanics, is derived. The critical resolved shear stress versus temperature for aluminium is then calculated.

Ph 145 UDC 550.838

Rajala, J. and Soikkeli, J.: *On the Determination of the Magnetic Dipole and Quadrupole Moments*. Acta Polytechnica Scandinavica, Applied Physics Series No. 145, Helsinki 1984, 19 pp. ISBN 951-666-181-5. ISSN 0355-2721

The magnetic dipole and quadrupole moments of a magnetized body in a homogeneous magnetic field are determined in terms of the components of the measured magnetic field. Integral formulae are derived for the centre of the body and for its volume multiplied by the susceptibility. The applicability of these formulae has been tested numerically.

Ph 146 UDC 539.125.074.85:519.642.3

Sandberg, J.V.: *Determination of Particle Flux Spectra with Multireaction Activation Detectors*. Acta Polytechnica Scandinavica, Applied Physics Series No. 146, Helsinki 1984, 57 pp. ISBN 951-666-187-4. ISSN 0355-2721.

Activation detectors constitute one method for measuring particle flux spectra at reactors and accelerators. The determination of the energy spectrum from a few discrete measurements leads to an underdetermined system of integral equations which does not have a unique mathematical solution, but by using some prior information on the spectrum and special unfolding programs physically relevant solutions can be obtained. The general purpose, least-squares regularization type unfolding program LOUHI78 is described and it is applied to unfolding high-energy secondary hadron spectra measured with multireaction spallation detectors at the CERN Super Proton Synchrotron and reactor neutron energy spectra measured with multicomponent activation detectors. The design, fabrication and testing of multicomponent detectors, where a number of component materials is irradiated and measured together, are also described.

Ph 147 UDC 620.92:536.2:621.577

Lund, P. D.: *Studies on Solar Heating Systems with Long-Term Heat Storage for Northern High Latitudes*. Acta Polytechnica Scandinavica, Applied Physics Series No. 147, Helsinki 1984, 48 pp. ISBN 951-666-192-0. ISSN 0355-2721.

This thesis is based on twelve different publications, which discuss simulation studies of liquid-based solar heating systems with different types of long-term heat storages for northern high latitudes. The computer models developed describe the energy system as a whole taking into account the dynamical couplings and restrictions. The models have been applied to various thermal performance analyses, and to different case studies regarding the general feasibility of a district solar heating system for a cold climate.

AUTHOR INDEX

ACTA POLYTECHNICA SCANDINAVICA

...a Scandinavian contribution to international engineering sciences

1958—1971 published under the auspices of the Scandinavian Council for Applied Research

in *Denmark* by the Danish Academy of Technical Sciences

in *Finland* by the Finnish Academy of Technical Sciences, the Swedish Academy of Engineering Sciences in Finland and the State Institute for Technical Research

in *Norway* by the Norwegian Academy of Technical Science

in *Sweden* by the Royal Swedish Academy of Engineering Sciences

As of 1972 the journal is published by the Finnish Academy of Technical Sciences. The Editor-in-Chief is Professor Mauri Luukkala and the editorial secretary is Ari Rautsara.

Acta Polytechnica Scandinavica is divided into the following sub-series:	*Subscription fee 1985*
Chemical Technology and Metallurgy Series, Ch *editor Professor Seppo Palosaari*	*Fmk 100.00*
Civil Engineering and Building Construction Series, Ci *editor Professor Jussi Hyyppä*	*Fmk 100.00*
Electrical Engineering Series, El *editor Professor Seppo Halme*	*Fmk 100.00*
Mathematics and Computer Science Series, Ma *editor Professor Reijo Sulonen*	*Fmk 100.00*
Mechanical Engineering Series, Me *editor Professor Matti Ranta*	*Fmk 100.00*
Applied Physics Series, Ph *editor Professor Mauri Luukkala*	*Fmk 100.00*

Subscriptions may be entered for the complete series or for one or more of the subseries. In addition single copies may be purchased through booksellers or directly from the publisher.

Backfile issues are also available on 35 mm microfilm from University Microfilms International, 300 North Zeeb Road, Ann Arbor, Michigan 48106, USA.

THE FINNISH ACADEMY OF TECHNICAL SCIENCES
Kansakoulukatu 10 A, 00100 Helsinki 10, Finland

Multiprint, Helsinki 1985